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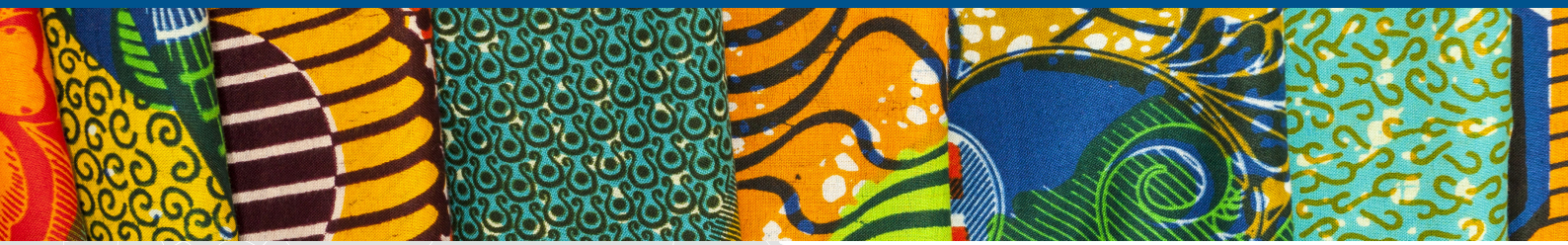

PROMOTING COTTON BY-PRODUCTS

In Eastern and Southern Africa

Investing in Uganda's cotton by-products

Briquettes and pellets production from cotton stalks and other biomass waste products

July 2019

Project: 1617K - Funded by the United Nations Development Account - 2016-2019

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Investing in Uganda's cotton by-products

Project Title: Briquettes and pellets production from cotton stalks and other biomass waste products

Total investment: US$ 263,075

Proposed project location: Mukono district

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For more information, please visit the project site at: www.unctad.org/commodities.

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List of Acronyms

BoU ..... Bank of Uganda

BPA ..... Bukalasa Pedigree Albar

CDO ..... Cotton Development Organisation

COMESA ..... Common Market for Eastern and Southern Africa

EAC ..... East African Community

FAO ..... Food and Agriculture Organisation

ha ..... Hectare

kg ..... Kilogram

KVA ..... Kilo-Volt-Ampere

kWh ..... Kilowatt hour

LPG ..... Liquefied Petroleum Gas

MEMD ..... Ministry of Energy and Mineral Development

MBPs ..... Megabits per second

MFPED ..... Ministry of Finance, Planning and Economic Development

MT ..... Metric Tonne

NFA ..... National Forestry Authority

NGOs ..... Non-Government Organisations

NSSF ..... National Social Security Fund

SADC ..... Southern Africa Development Community

UBOS ..... Uganda Bureau of Statistics

UGCEA ..... Uganda Ginners and Cotton Exporters Association

UGX ..... Uganda shillings

UIA ..... Uganda Investment Authority

URA ..... Uganda Revenue Authority

US$ ..... United States of America Dollars

USDA ..... United States Department of Agriculture

UNBS ..... Uganda National Bureau of Standards

URSB ..... Uganda Registration Services Bureau

VAT ..... Value-Added Tax

1. The cotton subsector in Uganda

1.1 Background

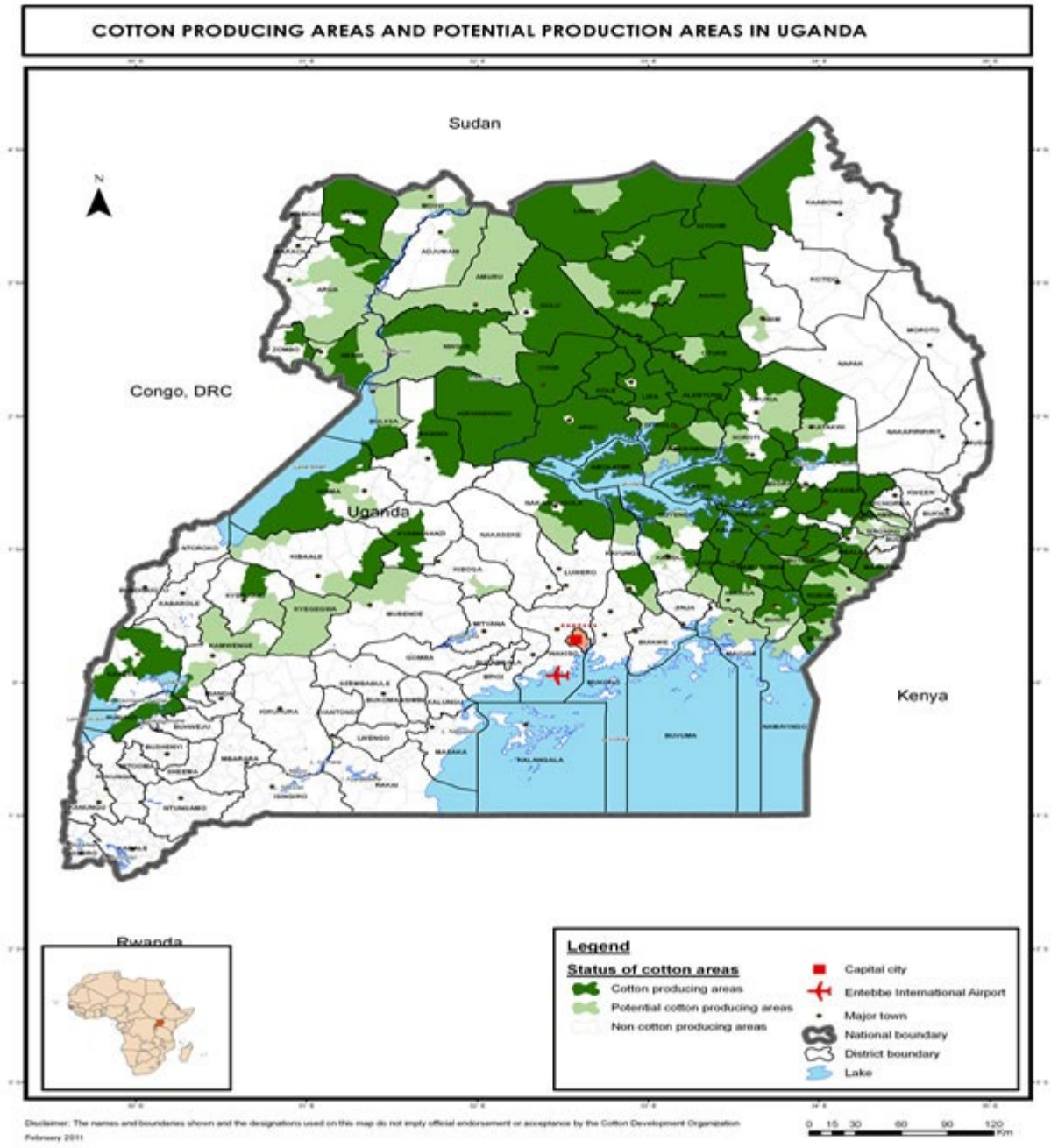
Uganda's history in cotton production dates back to the early 1900s. To date, the crop remains one of the most significant cash crops, supporting an estimated 2.5 million livelihoods. The growing demand for cotton worldwide has propelled exponential growth in the subsector. According to the United States Department of Agriculture (USDA), Uganda is one of the major exporters of cotton in Africa and the world, ranking 11th and 27th respectively, in 2018. In the same year, the subsector generated export earnings of 44.34 million United States of America dollars (US$), compared with US$ 50.70 million in 2017, and US$ 31.43 million in 2016 according to the Bank of Uganda.[1] Cotton was ranked as the country's 6th largest export crop in 2018, according to BoU. In the same year, Uganda was the 15th African cotton producer, according to USDA. The country has the highest cotton yields in the East African Community region and ranks 10th in Africa.[2] Uganda's cotton attracts premium prices on the international market and is rated among the preferred choices for several local and international buyers.[3] Cotton can be produced in most parts of Uganda (Ahmed and Ojangole, 2012). One hundred per cent of the crop grown today is of the Bukalasa Pedigree Albar (BPA) variety. The Serere Albar Type Uganda (SATU) variety is also mentioned occasionally, but was mainly grown in northern and eastern dry areas of Uganda until 1994.

1.2 Cotton growing areas

Uganda's favourable climatic conditions and nature of soils favour the growing of cotton in several parts of the country. Cotton is grown across approximately two-thirds of Uganda's land area (Lugojja, 2017). The main growing areas include Eastern, Northern, Lower West Nile and South Western regions in the Kasese area. The soil conditions are sandy and loamy, contributing to high cotton productivity. Cotton planting in the Northern region starts from April to June and receives one rainy season, while cultivation in the South region receives two rainy seasons, with planting occurring between June and July.

[1] Bank of Uganda (BoU) https://www.bou.or.ug/bou/rates_statistics/statistics.html
[2] United States Department of Agriculture
[3] Uganda Investment Authority (UIA), Cotton Sector Profile, available at http://www.ugandainvest.go.ug/images/Download Centre/SECTOR PROFILE/Cotton Sector Profile.pdf

Figure 1: Cotton growing areas



Source: http://www.cdouga.org/production/production-trends-earnings/

1.3 Key products

There are three main products derived from the cotton plant. These include lint, cottonseed, and cotton stalks. Lint is the major product produced but other parts of the plant, especially cottonseed, have been processed into several by-products in the cotton industry. The ginners produce cottonseed, which is processed by millers into linters, hulls, cottonseed oil and cake. The oil and cake are further processed into edible oil and animal feed, respectively. Whereas there is more advanced development in the cotton lint and cottonseed oil value chains in Uganda, the

development of other cotton by-products, such as the cotton stalks, has stagnated due to, for example:

- A lack of technologies;
- Limited knowledge about the value-added by-products that can be derived from residues in the chain;
- Limited knowledge about the marketability of cotton by-products; and
- A lack of data about the available volumes of raw materials, such as cotton stalks, which are destroyed at harvesting (Lugojja, 2017).

According to the survey by Shinyekwa, I. et al., (2018) cotton stalks can be used for the manufacture of particle boards, pulp and paper, hardboards, corrugated boards and boxes, microcrystalline cellulose, cellulose derivatives and as substrate for growing edible mushrooms. According to the survey, about 330,000 metric tonnes (MT) of cotton stalks are generated annually but most of the stalks are treated as waste and the bulk is disposed of by burning to prevent the spread of pests and insects.

1.4 Annual production

Uganda is among the top world producers of organic cotton. The subsector has witnessed a general increase in production over the last 10 years, although 2017/18 production remained below the peak production of 256,036 bales in the 2011/12 season. The low production is linked to lack of a domestic textile industry, and low use of purchased in-puts due to lack of rural credit (Baffes, 2009a, 2009b, 2010). According to the Cotton Development Organisation (CDO), which regulates the production and marketing of cotton in Uganda, cotton lint production has followed an upward trend since 2013/14 (Table 1.1). In 2017/18, cotton lint production stood at 202,357 bales and is projected to be 200,000 bales in 2018/19. The major problem of Uganda's cotton subsector according to some scholars is its low profitability, reflecting the displacement of cotton by food crops (Baffes, 2009b). Earnings from lint sales have also increased progressively from US$25.08 million in 2013/14 to about US$61.05 million in 2018/19. Similarly, earnings by farmers are projected to reach Uganda shillings (UGX), 190.80 billion by end of 2018/19 from UGX 49.84 billion in 2013/14.

Table 1.1: Annual cotton production 2011/12-2018/19

Year /season	Cotton lint production (bales @ 185 kg)	Earnings from lint sales (US$ million)	Earnings by farmers (UGX. billion)
2011/12	254,036	47.94	148.1
2012/13	102,619	30.19	59.83
2013/14	78,364	25.08	49.84
2014/15	93,093	22.04	56.74
2015/16	110,707	25.81	88.01
2016/17	151,071	41.64	136.11
2017/18	202,357	53.53	187.69
2018/19	200,000	61.05	190.80

***Source**: CDO, Uganda*

1.5 Biomass

Recent studies from Uganda Industrial Research Institute (UIRI) point to a high potential for Uganda to use cotton stalks to make briquettes for fuel using carbonised briquettes or non-carbonised, compressed pellets. According to UIRI, the carbonisation approach can produce 33 kilograms (kg) of charcoal from 100 kg of cotton stalks. The non-carbonisation approach, i.e. compression or densification, on the other hand, involves the collection, drying and pressing of cotton stalks using appropriate temperature, moisture content, compacting the stalks into high-quality densified fuel pellets.

Briquettes can be made from any biomass material. In Uganda the available biomass includes wood, agricultural waste, animal manure and municipal organic solid waste. Wood is the major form of biomass used but other agricultural residues are becoming a popular alternative (MEMD, 2013). Manufacturers use carbonised char and agricultural residues, but none has explored using cotton stalks as a raw material for the production of briquettes and pellets. Nevertheless, the Ministry of Energy and Mineral Development (MEMD, 2013) estimated that Uganda produces a total of 6.2 million MT of farm-level vegetal waste – including stalks from cotton, maize and sorghum, for example – representing a large, reliable potential supply of raw material for sustainable biomass energy projects in the country.

1.6 Briquettes and pellets from cotton stalks

Uganda has several micro producers of briquettes. However, the majority of them use primitive equipment, while others make briquettes manually, producing less than 2 MT annually, according to the Global Village Energy Partnership International Organisation (GVEP, 2012). The few using motorized fabricated machines by local artisans produce about 200 MT of briquettes per annum. There is thus the need to expand the briquette industry in Uganda by adopting new technology to increase productivity and make use of a variety of raw materials. Cotton stalks in a preliminary survey by BTG in 1990 revealed the potential for this substitution Williams (1990). Briquetting technology involves compressing small particles of organic waste with a binder, producing pellets or briquettes (Aishwariya & Amsamani, 2018).

The economic uses of briquettes and pellets are broad coupled with the growing demand fuelled by increasing charcoal prices and the depleting forest cover in the country. The competitive factors include the following:

a. Cotton stalks are sourced locally from farmers. This is a saving on transport and transit cost of the raw material.

b. The technology for producing carbonised briquettes or non-carbonised, pressed pellets is available at UIRI and can also be imported.

c. Uganda has enterprises engaged in briquetting and pelleting using other biomass products. Synergies with such firms can benefit new investors.

d. Uganda has a comparative advantage in harnessing the production of briquettes and pellets resulting from fertile soils and favourable climatic conditions that provide excellent growth conditions for cotton stalks and other agricultural residues.

e. Uganda has a young, abundant, and trainable workforce to provide manpower in the factory. Uganda has more than 40 universities, which produce over 20,000 graduates per year in various fields. Graduates with the required skills for the biomass briquetting industry are found at the school of forestry and environmental sciences, Nyabyeya Forestry College, as well as at technical, vocational and training institutions.

f. Briquettes usually have high specific density of 1,200 kg/m^3 and bulk density of 800 kg/m^3, depending on the compression, which give much higher boiler efficiency because of low moisture and higher density, as compared to firewood or loose biomass.

1.7 Relevant government initiatives

Uganda attaches great importance to forest conservation and efficient use of biomass energy. Briquettes and pellets are part of the biomass products expected to address some of the biomass energy challenges. The use of briquettes and pellets promotes value-addition to cotton by-products and creates employment opportunities for the growing population. In the cotton subsector, stalks have never had commercial utility, therefore adding value to them can create new income opportunities for households. The following interventions have been undertaken by the Government to harness production of briquettes and pellets in Uganda.

a. Regulation of charcoal production to discourage its use has increased the cost of the biomass fuel. The National Forestry Authority (NFA) controls cutting down of trees and levies fees on charcoal. Such measures have increased the demand for briquettes in the country.

b. Government has provided financing through the agriculture credit facility which disburses loans to eligible projects across the country to increase mechanization in agriculture (MFPED, 2018). Some briquettes producers such as Eco-Fuel Africa have secured funding from such initiatives.

c. Investment in agricultural research, science and technology has generated new affordable technologies for several communities. Uganda Industrial Research Institute has developed incubating technologies for making briquettes for fuel using cotton stalks. There are two forms that can be made, namely carbonized briquettes and non-carbonized, pressed pellets. The carbonized approach is preferred because it is smoke free and likely to be more attractive to domestic consumers and households, particularly charcoal users.

d. Provision of field extension services to increase the yields per hectare (ha) through the Uganda Ginners and Cotton Exporters Association (UGCEA) to train farmers in good agronomic practices such as crop establishment, pest and general crop management, and soil and water conservation in various cotton growing areas.

e. Supply of inputs such as fertilizers, pesticides, herbicides and seeds to farmers by CDO aim to boost production and increase the acreage planted which ultimately increases the cotton stalks produced per annum.

1.8 Specific investment opportunities

The cotton subsector has numerous opportunities for prospective investors, including:

a. Setting up medium to large-sized enterprises to manufacture between 1,000-2,000 MT of briquettes and pellets using imported equipment.

b. Provision of transport and related logistics services to briquettes and pellets manufacturers by collecting of carbonised char from the farmers to the factory.

c. Establishment of collection and training centres to chip and carbonise cotton stalks and other agricultural residues before transportation to factories.

d. Establishment of collection centres, and storage facilities for the cotton stalks.

e. Manufacturing briquettes made from municipal solid waste as the raw material.

f. Recycling of charcoal fines, small particles of charcoal lost during retail and distribution estimated.

g. Manufacture of non-carbonised briquettes to replace firewood for institutions and restaurants where indoor air pollution can be controlled.

h. Supply of locally fabricated motorised briquette machines made by skilled artisans for sale to briquettes manufacturers. For instance, compaction machines with capacities of more than 1,000 kg/day.

2. Project: Biomass briquettes and pellets

The project seeks to manufacture briquettes and pellets from cotton stalks and other agricultural residues. According to MEMD, population growth is the driver of biomass demand in Uganda since most households cannot afford modern, clean forms of energy like electricity and liquefied petroleum gas (LPG). Biomass energy is used across all sectors, with close to 100 per cent of rural households and 98 per cent of urban households using it as the primary energy source for cooking and heating. In Uganda, some manufacturers such as breweries have adopted use of agro-residues, such as coffee and rice husks, which are more cost effective instead of furnace oil technology. Briquettes and pellets are also used by rural and urban households, hotels, restaurants, small eateries, hospitals, and educational institutions.

2.1 Purpose and rationale

The purpose of the project is to produce briquettes and pellets for energy fuel, cooking and heating purposes. Briquettes and pellets will be produced for the domestic market and exported to the regional market. Cotton stalks and other agricultural residues will be used as raw materials. The project conserves the forest resource, contributes to Uganda's energy security and provides employment opportunities and incomes to people along the value chain. Investment in the project will therefore provide a livelihood to the local population and benefit Uganda as a whole.

2.2 Production and technology

Briquetting is defined as the compaction of small particles of organic waste together with a binder to form a pellet or a briquette block (Aishwariya & Amsamani, 2018). Whereas pellets are small round rods measuring between 6-10 mm in diameter, briquettes are larger in size measuring 90 mm or wider in diameter. Figure 2 shows a photo of different formats and sizes of compressed briquettes.

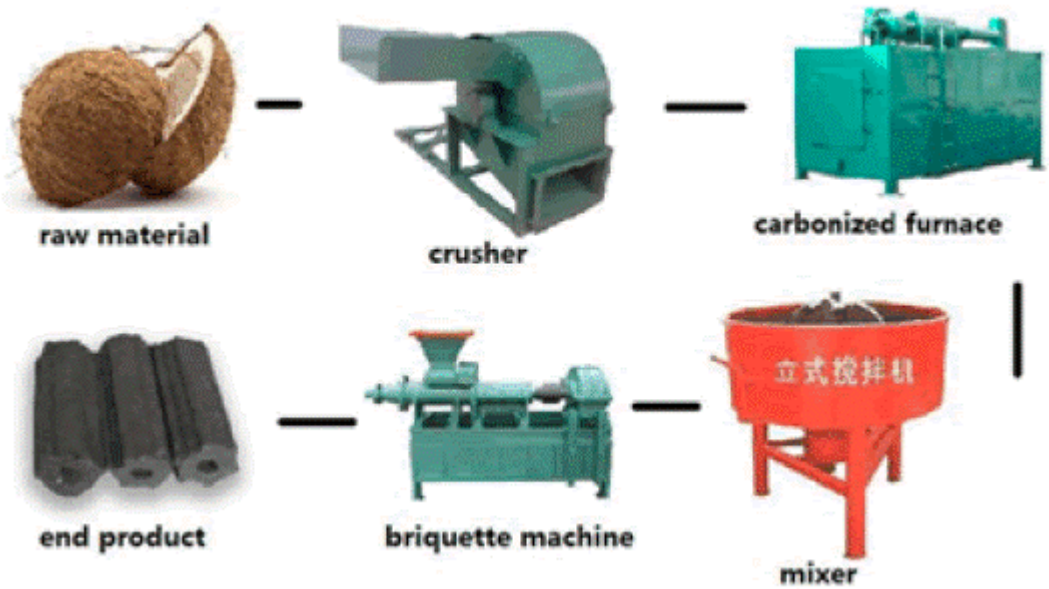
Figure 2: Types of Briquettes

Photo credit:https://www.omicsonline.org/publication-images/innovative-energy-shapes-sizes-7-221-g001.png

There are numerous advantages to using biomass briquettes as a source of energy. Briquettes have a higher thermal value, low ash content, uniform rate of combustion, a low moisture and density form, giving them better boiler efficiency (Aishwariya & Amsamani, 2018). Briquettes are cheaper than coal and their ash residue can be recycled as compost, unlike coal ash. The energy source has a ready market, high profit, good growth potential and a wide choice of raw materials. Briquettes are also easy to store and transport making them an ideal energy alternative in Uganda.

The moisture level in the raw material is expected to be less than 12 per cent. The raw material can be dried in the sun or a biomass rotary/turbo dryer. The cotton stalks or agriculture residues are collected, crushed, dried and briquetted (Lubwama & Yiga, 2018). The raw materials are transferred to a screw conveyor then to a hopper and through a motor. As compression increases, with pressure and temperature raises the lignin acts as a natural binder and causes compaction. The final product is ejected out and cooled to get the briquette or pellet. Figure 3 shows photos of each process step.

Figure 3: Steps involved in biomass briquetting

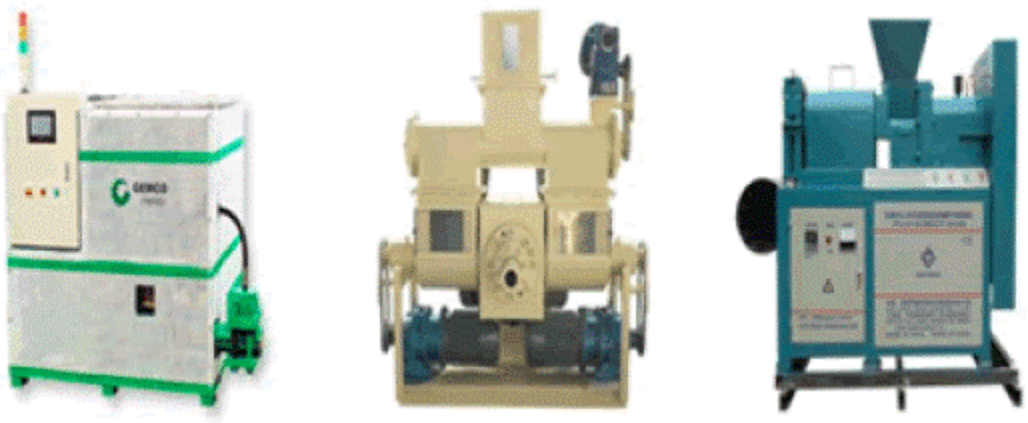


Source: https://www.omicsonline.org/publication-images/innovative-energy-biomass-briquetting-7-221-g003.png

There are three methods of briquetting: hydraulic, stamping, and screw press (see Figure 4). Each process differs in raw material size, moisture content, density, capacity, energy, lifetime of mould, PLC, noise, working environment and users. An explorative research on cotton ginning waste for

briquetting found that 52 per cent of the company's thermal requirements was met by this new energy source alternative to the fuel oil (Zabaniotou and Andreou, 2010).

Figure 4: Hydraulic, stamping and screw press briquetting machines



Source: https://www.omicsonline.org/publication-images/innovative-energy-Briquette-machines-7-221-g004.png

Table 1.2: Different types of briquetting machine and their characteristics features

	Hydraulic briquetting machine	Stamping Type Briquetting Machine	Screw Press Briquetting Machine
Raw material size / mm	3-20 mm	3-20 mm	3-5mm
Raw material moisture required	6%-18%	10%-20%	8%-12%
Product profile	 Φ=70 mm	 Φ=70 mm Pellet: 8 mm,10 mm, 22 mm, 30 mm	 Φ=40 mm, 50 mm, 60 mm, 70 mm
Product density/ g/cm^3	0.8-1.2	0.9-1.3	1-1.3
Capacity/ kg/h	125	800-1200	180-1000
Energy consumption/ kW/t	40-60	40-50	70-80
Mould lifetime	1000 h-1500 h, cooling not required to mould	1000 h-1500 h, cooling required to mould	1500-2000
Programmable logic controller (PLC)	yes	Yes, and vibration resistance	N/A
Noise	Lower than 70 dB	Higher than 85dB	Around 80dB
Working environment	Dust free	Dust free	With smoke and ash
Users	High requirement with automatic control and working environment, complicated raw material component.	High requirement with capacity (1-5 t/h)	Typically, the briquettes will be further processed to charcoal briquettes

Source: Aishwariya and Amsamani, 2018.

2.2.1 Production capacities

The proposed investment project has a production capacity of 1,500 MT per annum of charcoal briquettes and pellets. The plant will operate with a single daily shift. Production will start at 75 per cent capacity in the second year of operation and is expected to rise to 80 per cent in year 3, 85 per cent in year 4 and 100 per cent by year 5, driven by increasing demand for biomass fuels. Export is

projected to commence after the project reaches 100 per cent production, i.e. from year 5 onward. At full capacity, the plant will produce 125 MT per month and 5 MT per day.

2.2.2 Production process

The production process will follow five (5) major stages described below and depicted in Figure 5.

Stage 1: Carbonisation

- The cotton stalks and other agricultural residues are piled into the carboniser. All air inlets are closed before igniting the furnace. The oxygen intake is controlled in the combustion process. Water is added to extinguish the fire and complete the carbonizing process. During the carbonisation process, black smoke is cooled and purified by the condenser and liquefied into a mixture of char and water.
- The raw materials are carbonised into char to eliminate volatile compounds and moisture.

Stage 2: Crushing

- The raw materials, which may still be of variable shape and size, are placed into the grinder or milling machine and crushed into powder.

Stage 3: Binding

- After crushing the material into fine powder, binding agents, such as cassava starch, or fine clay, are mixed with water and the powder at high temperature and pressure, to enhance the binding process.

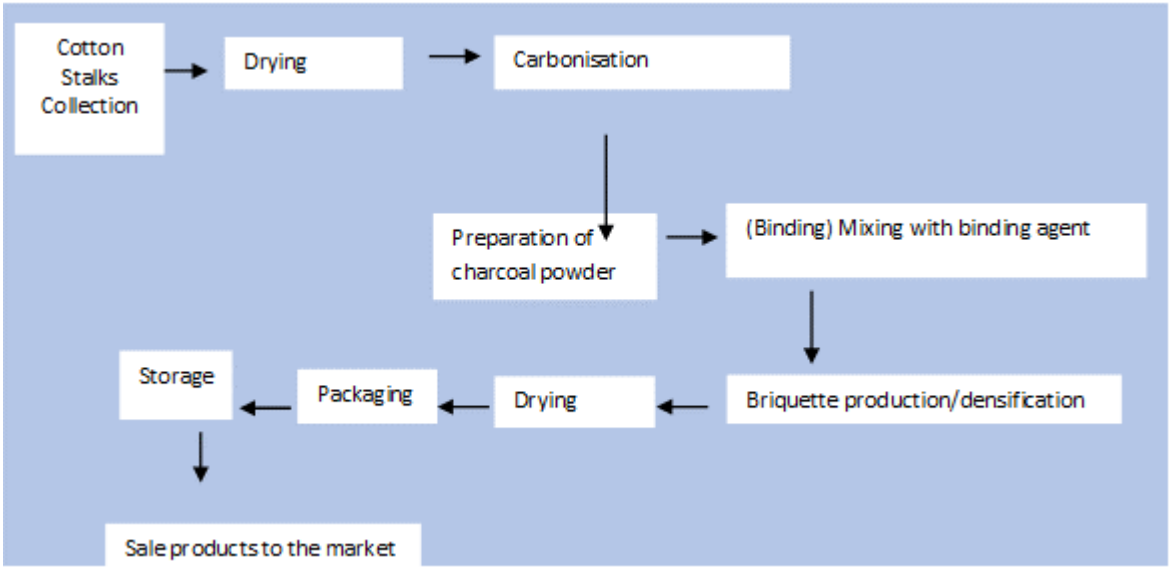
Stage 4: Drying

- The raw material is sun dried for about 3 to 4 days until the moisture content is lower than 10%.
- A heated fan, tunnel oven, flash dryer or solar dryer can be used to accelerate the drying process for the feedstock.

Stage 5: Briquetting

- After drying, the briquette machine is used to compress the material into a hollow finished briquette, using high temperature and high pressure.
- The machine can be calibrated to produce briquettes of specified sizes. The briquettes made in Uganda are usually 50 mm in diameter and about 4-5 cm in length.

Figure 5: Process flow diagram for briquette and pellet production



Source: *Author's interviews with briquette manufacturers in Uganda*

2.2.3 Technology options

The project will adopt both local and imported technology. Mobile carbonisers will be purchased locally, while the large-scale carbonising machine, transformer, cotton crusher, automatic briquetting machine, and semi-automatic flash drier, will be imported. For these machines, imported machinery is preferred because it is more widely available in larger capacities, necessary to achieve economies of scale.

Imported machinery and equipment can be purchased from India or China. Suppliers for various plant and machinery can be readily found on online marketplaces, such as IndiaMART or Alibaba. Some of the suppliers are listed in Annex XI.

3. Location, logistics and environment

3.1 Proposed location

The proposed location for the factory is Mukono district in central Uganda. The district is about 24 km east of Kampala capital city and its surrounding urban areas. Mukono district was selected due to its proximity to the target market segments and points of sale. The location will ease transportation, sales and distribution of briquettes and pellets to various customers located in the central region such as Kampala, Wakiso, Luwero, and Masaka. Other target markets include Jinja district in eastern Uganda and surrounding towns.

The proposed location will also allow the proposed plant to supply briquettes and pellets to industrial users in the nearby Kampala Industrial and Business Park, located in Namanve, Wakiso District. Uganda is also planning an industrial park and free zone along the Eastern Route of the Standard Gauge Railway (SGR) in Mukono District (approximately 3,000 acres). The Eastern SGR Route will run from Kampala to Malaba extending its sidings to the new industrial park, which represents business opportunities for the proposed plant.

3.2 Infrastructure

Transport infrastructure is central to economic development in Uganda due to its primary role in enhancing, trade, market accessibility, and industrial growth. The major mode of transport of goods in Uganda is by road. By end of 2018, the cumulative road network in the country stood at more than 158,000 km, including 4,257 km of paved road. Several national roads are under construction, including the Mukono-Kyetume-Katosi-Nyenga road which was 91 per cent complete by end of March 2018. The road is expected to connect the Mukono district to Jinja in the east and Kampala to the north and west. The road will facilitate transportation of raw materials and finished goods to major regions and towns bordering the district.

Uganda has invested in the installation of power lines in rural areas and waivers on connection fees started in 2018/19 to increase demand for electricity. By end of February 2018, 117 out of 121 districts including Mukono were connected to the main grid. During 2017/18, construction of the 33 kV distribution lines to connect Buikwe, Mukono, and 4 other districts was completed, according to MFPED. Uganda's power tariffs are expected to reduce significantly when the Karuma power project is commissioned, to approximately UGX 105, or US$ 0.03 per kilowatt hour.

3.3 Transportation costs

The raw material (carbonised char) will be transported by road using contracted agents. The targeted agents are those that regularly ferry merchandise from Kampala or Mukono to cotton growing areas. The estimated cost of a 12-tonne truck per load, from the raw material base to the factory, is about US$ 135. Other agricultural residues such as coffee husks, maize stalks and cobs, groundnut shells, and banana wastes will be purchased directly by the factory from distributors with cash on delivery at the farm gate. Other sources will include dumpsites. This is intended to develop a wide network of raw material suppliers. Similarly, the briquettes will be distributed by a 7,000 MT truck to established retail outlets such as food stalls or kiosks in major trading centres. The factory will also supply briquettes and pellets directly to institutions such as schools, hospitals, restaurants, hotels, and poultry farms.

3.4 Environmental considerations

Carbonised briquettes have a steady flame that does not produce smoke or odour. Briquettes and pellets are also a substitute for firewood, thus reducing waste and deforestation. The absence of sulphur and fly ash in briquettes makes them eco-friendly (Huang et al., 2017). The investor will carry out an Environmental Impact Assessment (EIA)[4] prior to commencement of the project and shall submit an EIA report to the National Environment and Management Authority (NEMA) for approval before commencement. The EIA is issued by NEMA within 3-6 months. NEMA assists investors to commence operations as soon as possible. Environment audits will be conducted annually to ensure that the factory is not polluting the environment and surrounding local communities. All workers will wear protective gear to protect them from inhaling dust and foreign particles.

[4] The list of Certified EIA Consultants is found on the NEMA website www.nema.go.ug.

4. Raw material

4.1 Annual requirements

The primary raw material for the project is carbonised char from cotton stalks. Since cotton has a single harvest per annum and would be available for only a limited period of the year, other raw materials must be sourced from locally available agricultural residues to sustain targeted levels of production year-round.

4.2 Cotton stalks

Anap (2014) estimates that one hectare of rain-fed cotton, can produce three MT of cotton stalks. According to CDO, Uganda has cultivated an average of 80,000 ha of cotton over the last five years and this is expected to reach 110,000 ha in 2018, up from 109,312 ha in 2017. This implies Uganda has the potential to produce over 300,000 MT/year of cotton stalks, with a high possibility of growth resulting from the supply of pesticides, herbicides, fertilizers and seed to farmers, which is expected to increase yields from the current average of about 780 kg of seed cotton per hectare (Horna, Kyotalimye, & Falck-Zepeda, 2009).

4.3 Other agricultural waste

MEMD (2013) estimated that Uganda produced 6.2 million MT of agricultural waste at the farm level in 2013 – see Table 4.1. This includes stalks from maize, sorghum and cotton. The same study estimated a further 2.6 million MT of agro-processing waste comprising, for example, bagasse and husks from maize, rice and coffee.

Table 4.1: Biomass supply in Uganda

Biomass type	Farm level vegetal waste[5]	Agro processing waste - bagasse	Agro processing waste – maize, rice, coffee husks, etc.
Sustainable harvest (MT millions)	6.2	1.4	1.2

Source: (MEMD, 2013)

The findings reveal that Uganda has the potential to produce sufficient agro-residues to support the production of briquettes. Depending on the business model adopted, it is possible for briquettes and pellets to capture a substantial portion of the Ugandan market. The main challenge however is sensitisation of the households on how to use the fuel energy source and switching from the conventional charcoal to briquettes or pellets which are relatively low cost compared to charcoal.

4.4 Availability

The primary raw material (carbonised char) from cotton stalks will be sourced locally from contracted farmers. Other agricultural residues such as rice husks, rice straws, coffee husks, cottonseed hulls, maize cobs, banana fibres, and other residues are also readily available on the local market from large commercial farms, and agro processing factories. The annual production of the agricultural residues in MT are summarised in Table 4.2. Bagasse (590,000 MT), maize cobs (234,000 MT), and coffee husks (160,000 MT) constitute the highest volumes of production. Bagasse

[5] Stalks of maize, cotton, sorghum, etc.

however has competing uses with sugar factories which use it to generate electricity. The project will also target other residues such as banana fibres, and tea wastes, among others.

Table 4.2: Annual production of agricultural residues

	Agricultural Residue	Annual Production ('000 MT)
1	Bagasse	590
2	Rice husks	30
3	Rice straw	55
4	Sunflower hulls	17
5	Cottonseed hulls	50
6	Tobacco dust	4
7	Maize cobs	234
8	Coffee husks	160
9	Groundnut shells	63
	Total	1,203

Source: (MEMD, 2013)

4.4 Competing uses of raw materials

Cotton stalks in Uganda had no commercial application or major competing use at the time of writing. Competition for the cotton stalks however will arise once the briquette manufacturers learn about its use as a raw material and the demand grows in future. Other agricultural wastes, such as coffee husks and maize stalks and cobs are often used as animal fodder and fertilisers. In some cases, cement industries fire their boilers with raw biomass.

4.5 Sourcing and logistics

Carbonised char from cotton stalks will be collected from cotton growing areas. Farmers will be contracted and supplied with mobile chipping and carbonising machines to collect, chip and carbonise the cotton stalks after harvest. Transport agents will be contracted by the factory to collect the carbonised stalks from geographically dispersed small farmers and deliver the raw material to the factory.

Other agricultural residues such as coffee husks, maize stalks and cobs, groundnut shells, and banana wastes will also be purchased by the factory from distributors with cash-on-delivery at the farm gate.

5. Market analysis

The market for briquettes in Uganda is categorised into four segments: domestic consumers, institutional consumers, industrial consumers and the export market. The majority of briquette manufacturers supply peri-urban and urban centres. Some compressed briquettes are produced, but carbonised briquettes are the main product, using charcoal powder as the raw material. Carbonised briquettes are sold to households, refugee camps, roadside food vendors, poultry farmers, and institutional consumers while the non-carbonised briquettes are sold to brickmaking, and cement industries, as well as institutional kitchens such as restaurants, schools and hospitals (Asamoah et al., 2017). The non- carbonised briquettes are also suitable for institutional markets because they can substitute for wood without modification of the stoves.

5.1 Market opportunities

There is a market opportunity for briquettes in Uganda, due to their comparative advantages as substitutes for fuels such as charcoal and coal.

Rising prices for charcoal have contributed to the briquetting business gaining momentum. In 2008 the average price of a 40 kg charcoal sack was UGX 15,000 (US$ 6), rising to UGX 25,000 (US$ 10) in 2009 and UGX 60,000 in 2011 (Ferguson, 2012). At the time of writing in May 2019, a sack of charcoal cost UGX 100,000 (US$ 27). Similarly, four pieces of firewood, considered a close substitute for charcoal, cost about UGX 2,000 (US$ 0.80).

By comparison, a 50 kg sack of charcoal briquettes cost about UGX 40,000 (US$ 10.80), according to current briquette manufacturers. The existing price trends, increased awareness of briquettes as a cheaper source of energy coupled with the consistent heat output, builds an economic case for using the energy source by domestic, industrial and institutional consumers.

Table 4.3: Average price of charcoal 2008-2019

	2008	2009	2011	2019
Average price of a 40 kg charcoal sack in UGX	15,000	25,000	60,000	100,000

Sources: Ferguson (2012), Author

The high-power tariffs (US$ 0.166) increase the cost of production for a medium industry manufacturer. The briquettes are a cheaper option for use in industrial boilers.

In addition, the growing demand for charcoal has outstripped the supply from industries based on legal forestry. As a result, illegal deforestation is rampant, threatening Uganda's forest cover. The combination of rising charcoal prices and the crisis of deforestation creates a market and policy opportunity for renewable substitutes such as biomass briquettes (Ferguson, 2012). As the Government steps up its enforcement of forestry regulations and consumers begin to demand more environmentally responsible fuels, the market position for briquettes and pellets will strengthen.

There are also regional market opportunities for the briquetting industry. Uganda's membership in the East African Community (EAC) and the Common Market for Eastern and Southern Africa States (COMESA) give it duty-free access to a total population of 120 million people. A steady market in the region starting with Kenya, Rwanda, and South Sudan will require signed contracts with bulk buyers to ensure consistent supply of briquettes and pellets to these markets. The main buyers of carbonised briquettes in Kenya are poultry farms, restaurants, hotels and safari camps (Asamoah et al., 2017). Securing the regional market however, requires consistency in the quality and supply of briquettes and well-integrated marketing and distribution.

Uganda signed the Africa Continental Free Trade Area (AfCFTA) agreement in March 2018. The CFTA gives the industry market access to more than 54 countries. The operational phase for the agreement was launched in July 2019 and ratified by 22 countries in May 2020.

5.2 Marketing and distribution

The proposed plant's briquettes will be sold to institutional and commercial consumers. The factory will distribute the briquettes by truck to institutional consumers such as schools, hospitals, restaurants, poultry farmers and barracks while the domestic consumers such as households will be reached through a network of retailers, particularly women, who own food stalls in trading centers located in peri-urban and urban areas.

6. Selected factor costs

6.1 Proposed infrastructure

Underlying assumptions are:

a. The plant will have its own waste disposal facility that will include a septic tank and soak pit which shall be constructed in the first year of the project.

b. Electricity tariffs will be lowered after commissioning Karuma Hydro-Power Plant in 2020.

6.2 Indicative utility and transportation costs

The table below is a summary of utility costs gathered from various sources. The electricity cost for a medium industry consumer with low voltage of 415 volts (V) and maximum consumption of 500kVa is about US$ 0.166. The cost of transporting a 20 feet and 40 feet container from the Mombasa port in Kenya to Mukono including clearing fees, charges and insurance is about US$3,300. Other indicative costs for broadband internet installation and connection to a fixed telephone line are shown in table 6.1 below. The costs for internet, telephone and transport below may vary depending on the service provider.

Table 6.1: Selected indicative utility & transportation costs

Category	Description	Unit Cost, US$
Electricity	Medium industry consumers Low voltage of 415 volts (V), with maximum consumption of 500 kVA	0.166
	Large industry consumers High voltage 11,000 V or 33,000 V with consumption between 500 – 1,500 kVA	0.10
	Extra Large industry consumers High voltage 11,000 V or 33,000 V with consumption exceeding 1,500 kVA and dealing in manufacturing	0.085
Internet	Broad band installation	2,000
	Broadband dedicated internet 3 megabits per second (Mbps), per month	800
Telephone	Fixed Line, per second on average	0.0011
Road	20ft & 40ft container from Mombasa to Mukono, including clearing fees, charges and insurance.	3,300
	20ft & 40 ft Container from Mukono to Mombasa, including clearing fees, charges and insurance	2,200

Note: The proposed plant falls under medium industry category

6.3 Proposed labour costs

Underlying assumptions are:

a. Proposed rates include health benefits, taxes and social security contributions.

b. All administrative and production management personnel are readily available.

c. The estimated number of staff is 32.

The estimated cost of a manager per month is US$ 350. The estimated cost of a professional staff working as an accountant in finance and administration and any other professional staff within the same category is US$ 220 per month. The cost of semi-skilled staff including machine operators is US$170 per month while the estimated cost of casual laborers is US$ 118 per month. The total costs of labour are illustrated in section 7.4.

7.0 Preliminary financial viability analysis of the proposed project

7.1 Underlying assumptions

The following are the underlying assumptions:

a. Purchasing of carbonised char will be carried out February-April after harvesting the cotton crop. The factory will purchase sufficient volumes to enable production all year round. In addition, other agricultural residues will be supplemented to ensure constant supply of the raw material.

b. The factory will provide crushers/chipping machines and carbonising kilns to farmers.

c. Farmer groups will engage in chipping, collecting, and carbonising the cotton stalks into char at a cost sharing arrangement.

d. Carbonised char will be purchased from farmers at a cost of UGX 75/= (US$0.02) per kilogramme. The current selling price for a kilogramme of charcoal briquettes is UGX 1,000 (US$0.27).

e. Transport agents will pay and collect the carbonised char and transport it to the factory.

f. The production capacity of the briquette and pellet production line is based on a single shift working 8 hours per day. There are 6 working days per week.

g. Funds will be mobilized in the 1st year of project implementation.

h. Investor contributes 60 per cent equity and the balance will be a US$ bank loan from a commercial bank.

i. Funds will be borrowed in US$ from a local bank at 8% interest rate.

j. Working capital for the first three (3) months will be available before production commences.

k. All staff required will be trained and recruited by the end of the 1st year of implementation.

l. The factory will stock up to 100 tonnes of briquettes at a time to cover demand during the rainy season when production drops due to slower outdoor drying. Outdoor drying will supplement the flash drier to reduce costs of production.

7.2 Proposed implementation schedule

The implementation schedule for year 1 of the project is shown in Table 7.1. Production will commence in January of year 2, at 75 per cent capacity utilization. Sales will also commence in year 2. Full (100 per cent) capacity utilization will be attained in year 5, when total sales reach US$ 405,405.

Table 7.1: Implementation schedule

	Activity	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1	Selection and acquisition of site												
2	Construction of building and factory sheds												
3	Financial arrangements												
4	Procurement of machinery												
5	Installation of electricity, machinery and other facilities												
6	Training												

7.3 Total capital investment

The estimated capital investment of the proposed project is US$ 263,075, according to breakdown shown in table 7.2 below. The capital investment includes purchase of land, civil works and construction of the factory, procurement of machinery and equipment, office furniture, pre-operating expenses including registration costs, costs of a truck for transporting the briquettes, connection to power, and water installation. The investor contributes 60 per cent equity and 40 per cent will be a long-term bank loan from a commercial bank.

Table 7.2: Estimated total investment of the project (US$)

	Item description	Quantity	Unit Price	Year 1
1	Land and site preparation (acres of land)	2	7,000	14,000
2	Civil works and built up area	1	97,140	97,140
3	Machinery and equipment	1	46,200	46,200
4	Office Furniture and equipment	1	6,148	6,148
5	Pre-operating expenses	1	2,000	2,000
6	Electricity and water installation	1	45,000	45,000
7	Heavy duty truck (7,000 tonnes)	1	42,857	42,857
8	Water system installation)	1	9,730	9,730
	Total			**263,075**
	Capital structure			
	Equity (60%)			157,845
	Long term debt/grant (40%)			105,230

7.4 Fixed capital

i) Land & building

The land to be procured is 0.8 hectares, equivalent to 2 acres. Each acre costs about US$ 7,000. It is assumed that the land will be located close to a road. Forty (40) per cent of the site will be devoted to buildings, leaving the rest for drying raw material, parking, loading and offloading. The estimated cost of construction is US$ 97,140. The cost of construction is US$ 30 per square meter.

ii) Machinery and equipment

The mobile carbonising machines will be fabricated in Uganda by skilled artisans. Other machines such as the crusher, automatic briquetting machine, and semi-automatic air flash drier will be imported from India or China. Electricity includes the cost of the transformer and installation at the factory. Office furniture, computers and accessories, and the truck will be purchased locally. The estimated cost of machinery and equipment is US$ 52,348. The details are summarized below.

Table 7.3: Estimated machinery, equipment and furniture costs (US$)

A	Machinery and equipment	Quantity	Unit Cost	Total Cost
1	Large scale carbonising machine	1	4,000	4,000
2	Mobile carbonising machines	4	1000	4,000
3	Cotton Crusher	2	3,500	7,000
4	Automatic briquetting machine	1	22,500	22,500
5	Semi-Automatic Air Flash Dryer	1	8,700	8,700
	Sub total			**46,200**
B	**Furniture and office equipment**	**Quantity**	**Unit Cost**	**Total Cost**
1	Computers and peripheries	5	714	3,571.43
2	Laser jet printers-1020 series	1	309.52	309.52
3	Office desk	5	190.48	952.38
4	Office chair	5	71.428	357.14
5	Office cabinets	2	176.19	352.38
6	Telephone set	1	57.14	57.14
7	Reception waiting chairs	3	23.8	71.43
8	Money safe	1	476.19	476.19
	Sub total			**6,148**

7.5 Management, occupancy and office running costs

The management costs and other staff costs are US$ 87,577. The occupancy costs comprising costs for water and electricity are US$ 21,562, while the office running costs which include costs for stationary, printing, photocopying, telephone, internet, sundries and fuel are US$ 8,932.

Table 7.4: Estimated management, occupancy and running costs (US$)

A. Management costs	No. of staff	Monthly salary (US $)	Total annual salary	NSSF Contribution	Total
Managerial and administration	4	350	16,800	1,680	18,480
Finance, administration, sales and marketing	8	220	21,120	2,112	23,232
Semi-skilled staff	5	170	10,200	1,020	11,220
Casual labourers	15	118	21,240	2,124	23,364
	Subtotal	**858**	**69,360**	**6,936**	**76,296**
Other staff costs	No. of staff	Unit value per staff year	Annual amount	Total	
Staff uniforms and protection clothing	32	41	1,297		1,297
Meals for staff	32	1	9,984		9,984
Total other staff costs			**11,281**	-	**11,281**
Total salaries and other staff costs			**80,641**	**6,936**	**87,577**

B. Occupancy costs	Unit	Quantity per month	Unit price (US$)	Total monthly	Total annual(US$)
Electricity	Kilo watts	10,000	0.166	1,660	19,920
Water	mm*3	150	0.912	136.80	1,642
Total		**10,150**		**1,797**	**21,562**

C. Office running costs	Quantity	Unit price (US$)	Total amount (US$
Stationary (reams of paper)	24	5	110.27
Box and Arch Files	24	2	42.16
Photocopying and Printing toner (cartridges)	8	76	605.41
Telephone	12	81	972.97
Office sundries	12	27	324.32
Internet connectivity/services	12	81	972.97
Fuel for vehicles (UGX 70,000 every day)	52	114	5,902.70
Total			**8,931.81**
Total expenses (A+B+C)			**118,070**

7.6 Financial analysis

(a) Profitability

The financial analysis of the project is summarized in annexes I-IX. The analysis covers 11 years. The project is profitable. At the end of year 2 the net profit realized after tax is US$ 52,053. Year 3 net profit is US$ 62,601, and Year 4 net profits further increase to US$ 72,820. The net profits reach their peak in the fifth year at US$ 103,767. The positive net profit ratio indicates that more profits will be earned from additional sales revenues.

Table 7.5: Profit and loss statement (US$)

Profit and Loss Statement (US$)	Year1	Year 2	Year 3	Year 4	Year 5
Total gross margin	**0**	**229,723**	**245,038**	**260,353**	**306,297**
Selling, general and admin costs					
Salaries and other staff costs	87,577	90,205	92,911	95,698	98,569
Occupancy Costs (water and electricity)	21,562	22,208	22,875	23,561	24,268
Office Running Costs	8,931	9,199	9,475	9,759	10,052
Sales and marketing	0	4,594	4,901	5,207	6,126
Insurance costs	2,631	2,631	2,631	2,631	2,631
Equipment Maintenance	2,631	2,631	2,631	2,631	2,631
Audit and legal fees	2,000	2,060	2,122	2,185	2,251
Total	**125,331**	**133,528**	**137,544**	**141,672**	**146,527**
Profit before interest and depreciation (PBID)	-125,331	96,195	107,494	118,681	159,770
Depreciation	17,627	15,099	13,012	11,285	9,849
Interest	8,418	6,735	5,051	3,367	1,684
Profit before taxes (PBT)	-151,376	74,362	89,430	104,029	148,238
Corporation Tax (30%)	(45,413)	22,309	26,829	31,209	44,471
Net Profit	**-105,963**	**52,053**	**62,601**	**72,820**	**103,767**

(b) Return on investment

The return on investment in year 2 is 32.98 per cent. It increases to 39.66 per cent in year 3 and 46.13 per cent in year 4. In year 5 the return on investment further peaks at 65.74 per cent. With continued profitability, payback period is in 5 years of operation as illustrated in table 7.6.

Table 7.6: Return on investment

Distribution of Profits (US$)	Year 1	Year 2	Year 3	Year 4	Year 5
PBID	(125,331)	96,195	107,494	118,681	159,770
Interest	8,418	6,735	5,051	3,367	1,684
Depreciation	17,627	15,099	13,012	11,285	9,849
Operating Profit	(151,376)	74,362	89,430	104,029	148,238
Corporation Tax (30%)	(45,413)	22,309	26,829	31,209	44,471
Profit After Tax	(105,963)	52,053	62,601	72,820	103,767
Return on Investment (%)	**(67.13)**	**32.98**	**39.66**	**46.13**	**65.74**

(c) Feasibility

The feasibility of the project is shown in Annex VII. The Net Present Value (NPV) is a summation of the discounted cash flows for years 1 - 11 of the project. The total sum is US$ 488,799. The project has a positive NPV and is therefore feasible.

8. Regulation, licenses and certifications

8.1 Licenses

An investor in a manufacturing facility for Briquettes and pellets requires the following licences to start business in Uganda:

a. Investment licence

b. Trading licence.

Table 8.1: Licences required

S/N	Name of Licence/Permit	Cost in US$	Issuing Authority	Licence Processing Time
1.	Investment licence	Free	Uganda Investment Authority	2 days
2.	Trading licence	Cost varies based on location	Municipal council	1 week

Procedure for acquiring an investment license

A Foreign investor requires a minimum of US$ 100,000 in planned investment in order to secure an Investment license from UIA, whereas the minimum planned investment for a local investor is US$ 50,000. Section 15 (1) of the Investment Code Act, 2019 provides a minimum investment capital requirement for registration of foreigners and domestic investors. The threshold for both categories awaits issuance of the Statutory Instrument by the Minister responsible for Finance.

In order to acquire the Licence, the Investor must carry out the following steps:

a) Step 1 - Register the company in Uganda at the URSB and obtain the Memorandum and Articles of Association, and a certificate of incorporation.

b) Step 2 - Apply by filling the UIA form 1 and attach copies of the following documents:

i. Certificate of incorporation

ii. Memorandum and Articles of association

iii. Business plan

iv. Bank statement for the company directors

v. Copy of the land title or tenancy agreement to confirm location

vi. Passport copy in colour of foreign shareholders or a copy of the national identification for local shareholders

vii. Bill of lading to confirm importation of machinery (exceptional)

viii. EIA Report/Certificate of Approval by NEMA

The Investment Licence will be issued online within two days on submission and verification of the required documentation and evidence indicating registration of the business, a business and investment plan, evidence of funds, and proof of location. The whole procedure from incorporation of a company to investment licence application and issuance is laid out comprehensively on the eBiz portal www.ebiz.go.ug.

8.2 Product quality and standards testing

Quality control and standards testing in Uganda is supervised by Uganda National Bureau of Standards (UNBS).Uganda has Standards 765:2007 for wood charcoal and charcoal briquettes for household. These can be accessed from the UNBS at a cost of UGX 40,000. The standards specify requirements for charcoal derived from wood, in lump or briquette form intended for household use. Standards for making briquettes and pellets for industrial use using agricultural residues such as cotton stalks are yet to be developed.

9. Workforce skills and availability of specialized skills

Uganda has a ready supply for skilled and semi-skilled workforce. The briquette and pellets industry can train and employ technicians from public and private universities and technical colleges such as Makerere University Kampala, Kyambogo University, Uganda Technical College Elgon, Makerere University Business School and Uganda Martyrs University Nkozi. The labour rates for technicians or machine operators are competitive ranging between US$ 118-176 per month.

10. Tax & non-tax incentives

Uganda offers competitive tax and non-tax incentives to greenfield and existing investors. The incentives are provided to both domestic and foreign investors depending on the sector or industry.

10.1 Tax incentives

A manufacturer of briquettes and pellets can benefit from the following incentives in accordance with the tax law in Uganda:

a. VAT deferment on plant and machinery is applicable, where payment of VAT at importation on specified imports is postponed to a future date. The cost of the plant and machinery should be at least US$22,500 and above.

b. Industrial replacement spares parts used exclusively on industrial machinery classified in Chapters 84 and 85 of the EAC Common External Tariff are exempted from all taxes under the Fifth schedule of the East African Community Customs Management Act, 2004.

c. VAT is deferrable for pre-fabricated buildings for factory use imported by registered manufacturers or other entities such as warehouse construction.

d. 100 per cent training expenditure on scientific research is allowed for Ugandan employees as a deduction for income tax.

e. An initial capital deduction of 50 per cent is allowed on plant and machinery and 20 per cent on industrial buildings situated in the radius of 50 km from Kampala.

f. Losses can be carried forward and allowed as a deduction in the following year of income.

g. 10-year income tax exemption is granted to manufacturers and exporters of consumer or capital goods. The exemption is granted if at least 80 per cent of the raw materials are sourced in Uganda and 80 per cent of the manufactured goods are exported.

h. Taxpayers with commercial buildings that are also used as offices are given an industrial building depreciation allowance at a rate of 5 per cent for 25 years.

i. VAT Supplies are exempt to operators within an industrial park, free zone or a single factory operator of any business outside an industrial park or free zone. The minimum capital investment must be US$ 15 million for foreigners and US$ 10 million for citizens.

j. Six per cent withholding tax exemptions for Uganda Revenue Authority compliant taxpayers.

10.2 Non-tax incentives

Uganda provides non-tax incentives to investors in the form of bilateral investment and trade agreements, double taxation agreements as well as national treatment and non-discrimination benefits:

g. Bilateral Investment and Trade Agreements (BITs)

   Uganda has entered into several BITs agreements for the promotion and protection of investment in Uganda. The BITs provide best investment practices, guarantee against expropriation, national treatment and non-discrimination, compensation for losses, repatriation of investment and returns, and dispute settlement among others. These include: - Denmark, Egypt, France, Germany, Italy, Netherlands, South Africa, Switzerland, United Kingdom & Northern Ireland.

h. Double Taxation Agreements (DTAs)

i. Uganda has signed Double Taxation Agreements with the following: Denmark, India, Mauritius, Netherlands, Norway, South Africa and United Kingdom.

j. National Treatment and Non-discrimination

i. Uganda does not restrict the percentage of equity that foreign nationals may hold in a locally incorporated company. There are no rules or regulations restricting joint-venture arrangements between locals and foreigners or restrictions prohibiting the acquisition of Ugandan firms by foreign-owned firms.

ii. Uganda imposes no limit on equity ownership. Investors are free to bring in and take out their capital. In practice, a company faces no obstacles in divesting from its assets in Uganda.

iii. Non-citizens can lease land up to 99 years.

iv. Entry/work permits are usually granted to key personnel of foreign enterprises approved to operate in Uganda. Any enterprise, local or foreign, can recruit expatriates for any category of skilled manpower where Ugandans are not available. In this case, however, the investor must prove the need for such employees.

v. Investors can invest in any part of Uganda as long as security and environmental laws are observed. Investments are not permitted in protected areas.

11. Applicable taxes

Uganda's tax structure is provided in the domestic tax laws of Uganda and the EAC Common External Tariff. The following taxes may apply to the investor depending on the goods and services supplies:

a. Import duty (4%, 6% or 7%) COMESA rates, and 0%, 8%, 10%, 25% and above 25% for various sensitive goods under the EAC Common External Tariff.

b. 30% corporate tax applicable on profits.

c. 6% withholding tax to some goods and services transactions and for imported goods.

d. 18% value added tax for supplies.

e. Infrastructure levy may also be applicable.

f. Property tax payable to the local authorities within the location of the factory.

NOTE: *The investor should consult URA Customs department for advice on applicable taxes before a consignment is brought into the country.*

12. Security of investment

Security of the investment in Uganda is guaranteed by the Constitution of Uganda, and the Investment Code Act 2019. Uganda is also a signatory to major international trade and investment-related institutions including the Multi-lateral Investment Guarantee Agency, Overseas Private Investment Corporation, Convention on the recognition and enforcement of foreign arbitral award, Islamic Corporation for the Insurance of Investment and Export Credit (ICIEC), International Centre for Settlement of Investment Disputes, and the Agreement on Trade-Related Aspects of Intellectual Property Rights among others.

13. Risks and mitigation strategies

The investment profile is based on assumptions. Unanticipated alterations of the environment may affect the implementation and success of the project. The potential risks identified are based on the

information collected at the time of developing the profile. The proposed mitigation measures can be planned in advance and put into consideration during the commencement and implementation of the project.

Table 13.1: Risks and mitigation strategies

	Risk	Probability H/M/L	Impact S/M/L	Mitigation	Responsibility
1.	Failure to increase demand for carbonised briquettes	**L**	**S**	Sell improved charcoal cook stoves & water boilers	Investor
2.	Low product quality	**M**	**S**	Research on improved and cost- effective technologies	Investor
3.	Low consumer awareness on use of briquettes and pellets as an alternative energy source for cooking and heating	**M**	**S**	Consumer sensitisation programmes and activities Market & target specific market segments	MEMD Investor
4.	Inadequate supply of carbonised char & agricultural residues	**M**	**S**	Contractual agreements with groups of small-holder and subsistence farmers for reliable supply of cotton stalks & agricultural residues Equip & train farmers on use of charcoal kilns	Investor

Key

1. Probability/Likelihood
- H- High
- M- Moderate
- L- Low

2. Impact/Consequence
- S-Severe
- M-Moderate
- L-Low

References

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Annex I: Loan repayment schedule

Long- Loan schedule	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Term Loan Required	105,230					
Opening Loan Balance	0	105,230	84,184	63,138	42,092	21,046
Loan Repayment	0	21,046	21,046	21,046	21,046	21,046
Closing Loan Balance	105,230	84,184	63,138	42,092	21,046	0
Interest on Loan (8%)	8,418	6,735	5,051	3,367	1,684	0
Front End Fee (1%)	1,052	0	0	0	0	0
Loan Insurance (3%)	3,157	0	0	0	0	0
Total Annual Debt Service	12,628	27,781	26,097	24,413	22,730	21,046
Monthly debt service	1,052	2,315	2,175	2,034	1,894	1,754

Annex II: Sales revenue statement (US$)

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11
Briquettes											
Installed Capacity (MT)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Capacity Utilisation (%age)	0%	75%	80%	85%	100%	100%	100%	100%	100%	100%	100%
Quantity of Briquettes produced (kgs)	-	1,125,000	1,200,000	1,275,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000
Price per kg in US$	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270	0.270
Value of Briquettes	$0	$304,054	$324,324	$344,595	$405,405	$405,405	$405,405	$405,405	$405,405	$405,405	$405,405
Less direct costs											
Raw Materials											
Carbonised Char											
Quantity of Carbonated Char (kg)	-	937,500	1,000,000	1,062,500	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000
Unit Cost Price of carbonated char	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Cost of Carbonated char	-	18,750.00	20,000.00	21,250.00	25,000.00	25,000.00	25,000.00	25,000.00	25,000.00	25,000.00	25,000.00
Cassava Starch											
Quantity of cassava starch	-	225,000	240,000	255,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
Unit price of cassava starch	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Cost of cassava starch	-	49,500.00	52,800.00	56,100.00	66,000	66,000	66,000	66,000	66,000	66,000	66,000
Packaging materials	0	6,081	6,486	6,892	8,108	8,108	8,108	8,108	8,108	8,108	8,108
Total Cost of raw materials	-	***74,331.08***	***79,286.49***	***84,241.89***	***99,108.11***	***99,108.11***	***99,108.11***	***99,108.11***	***99,108.11***	***99,108.11***	***99,108.11***
Gross Margin Briquettes	0	229,723	245,038	260,353	306,297	306,297	306,297	306,297	306,297	306,297	306,297
Total Annual Gross Margin	0	229,723	245,038	260,353	306,297	306,297	306,297	306,297	306,297	306,297	306,297

Annex III: Profit and loss statement (US$)

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11
Total gross margin	**0**	**229,723**	**245,038**	**260,353**	**306,297**	**306,297**	**306,297**	**306,297**	**306,297**	**306,297**	**306,297**
Selling, general and admin costs											
Salaries and other staff costs	87,577	90,205	92,911	95,698	98,569	101,526	104,572	107,709	110,940	114,269	117,697
Occupancy Costs (water and electricity)	21,562	22,208	22,875	23,561	24,268	24,996	25,746	26,518	27,314	28,133	28,977
Office Running Costs	8,931	9,199	9,475	9,759	10,052	10,353	10,664	10,984	11,313	11,653	12,002
Sales and marketing	0	4,594	4,901	5,207	6,126	6,126	6,126	6,126	6,126	6,126	6,126
Insurance costs	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631
Equipment Maintenance	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631	2,631
Audit and legal fees	2,000	2,060	2,122	2,185	2,251	2,319	2,388	2,460	2,534	2,610	2,688
Total	**125,331**	**133,528**	**137,544**	**141,672**	**146,527**	**150,581**	**154,757**	**159,058**	**163,488**	**168,051**	**172,751**
PBID	**-125,331**	**96,195**	**107,494**	**118,681**	**159,770**	**155,716**	**151,540**	**147,239**	**142,809**	**138,246**	**133,546**
Depreciation	17,627	15,099	13,012	11,285	9,849	8,650	7,646	6,800	6,084	5,475	4,955
Interest	8,418	6,735	5,051	3,367	1,684	-	-	-	-	-	-
PBT	-151,376	74,362	89,430	104,029	148,238	147,066	143,895	140,440	136,725	132,771	128,591
Corporation Tax	(45,413)	22,309	26,829	31,209	44,471	44,120	43,168	42,132	41,018	39,831	38,577
Net Profit	**-105,963**	**52,053**	**62,601**	**72,820**	**103,767**	**102,946**	**100,726**	**98,308**	**95,708**	**92,940**	**90,014**

Annex IV: Working capital (US$)

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11
Selling, general and admin costs	125,331.2	133,527.7	137,544.2	141,672.0	146,527.0	150,581.1	154,756.9	159,058.0	163,488.1	168,051.2	172,751.1
Total Cost of raw materials	-	74,331.1	79,286.5	84,241.9	99,108.1	99,108.1	99,108.1	99,108.1	99,108.1	99,108.1	99,108.1
Total	125,331.2	207,858.8	216,830.7	225,913.8	245,635.1	249,689.2	253,865.1	258,166.1	262,596.3	267,159.3	271,859.2
Increase	**125,331.2**	**82,527.6**	**8,971.9**	**9,083.2**	**19,721.2**	**4,054.2**	**4,175.8**	**4,301.1**	**4,430.1**	**4,563.0**	**4,699.9**

Annex V: Return on investment (US$)

	Year1	Year2	Year3	Year4	Year 5	Year6	Year7	Year8	Year9	Year10	Year11
PBID	(125,331)	96,195	107,494	118,681	159,770	155,716	151,540	147,239	142,809	138,246	133,546
Interest	8,418	6,735	5,051	3,367	1,684	-	-	-	-	-	-
Depreciation	17,627	15,099	13,012	11,285	9,849	8,650	7,646	6,800	6,084	5,475	4,955
Operating Profit	(151,376)	74,362	89,430	104,029	148,238	147,066	143,895	140,440	136,725	132,771	128,591
Corporation Tax (30%)	(45,413)	22,309	26,829	31,209	44,471	44,120	43,168	42,132	41,018	39,831	38,577
Profit After Tax	(105,963)	52,053	62,601	72,820	103,767	102,946	100,726	98,308	95,708	92,940	90,014
Return on Investment (%)	(67.13)	32.98	39.66	46.13	65.74	65.22	63.81	62.28	60.63	58.88	57.03

Annex VI: Cash flow statement (US$)

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11
Sources:-											
Profit after tax	(105,963)	52,053	62,601	72,820	103,767	102,946	100,726	98,308	95,708	92,940	90,014
Depreciation	17,627	15,099	13,012	11,285	9,849	8,650	7,646	6,800	6,084	5,475	4,955
Long Term Loan	105,230	-	-	-	-	-	-	-	-	-	-
Promoter's Contribution	157,845	-	-	-	-	-	-	-	-	-	-
Total sources	174,738	67,152	75,614	84,105	113,615	111,596	108,372	105,107	101,792	98,415	94,969
Uses:-											
Capital expenditure	263,074	-	-	-	-						
Working capital	125,331	82,528	8,972	9,083	19,721	4,054	4,176	4,301	4,430	4,563	4,700
Repayment of Term Loan + Interest	12,628	27,781	26,097	24,413	22,730	21,046	-	-	-	-	-
Total uses	401,033	110,308	35,069	33,496	42,451	25,100	4,176	4,301	4,430	4,563	4,700
Opening cash	-	(226,296)	(269,452)	(228,907)	(178,299)	(107,134)	(20,638)	83,558	184,364	281,726	375,577
Surplus/(deficit)	(226,296)	(43,156)	40,545	50,608	71,164	86,496	104,196	100,806	97,361	93,852	90,269
Closing cash	(226,296)	(269,452)	(228,907)	(178,299)	(107,134)	(20,638)	83,558	184,364	281,726	375,577	465,846

Annex VII: Discounted cash flow statement (US$)

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11
	(226,296)	(269,452)	(228,907)	(178,299)	(107,134)	(20,638)	83,558	184,364	281,726	375,577	2,018,668
Discounting:											
Required rate of return	8%										
Discounting Factor	0.93	0.86	0.79	0.74	0.68	0.63	0.58	0.54	0.50	0.46	0.43
Discounted Cash flow	(209,533)	(231,012)	(181,714)	(131,055)	(72,914)	(13,006)	48,755	99,606	140,933	173,965	865,772
Net Present Value	**489,799**										

The NPV =US$ 489,799. The project is feasible

Annex VIII: Break-even analysis

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11
Fixed costs											
Salaries and other staff costs	87,577.3	90,204.6	92,910.8	95,698.1	98,569.0	101,526.1	104,571.9	107,709.0	110,940.3	114,268.5	117,696.6
Insurance costs	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7
Equipment Maintenance	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7	2,630.7
Audit and legal fees	2,000.0	2,060.0	2,121.8	2,185.5	2,251.0	2,318.5	2,388.1	2,459.7	2,533.5	2,609.5	2,687.8
Office Running Costs	8,930.8	9,198.7	9,474.7	9,758.9	10,051.7	10,353.3	10,663.9	10,983.8	11,313.3	11,652.7	12,002.3
Depreciation	17,626.6	15,098.6	13,012.3	11,284.7	9,848.6	8,650.1	7,645.5	6,799.7	6,084.0	5,475.4	4,955.1
Interest	8,418.4	6,734.7	5,051.0	3,367.4	1,683.7	-	-	-	-	-	-
Total fixed costs	***129,814.6***	***128,558.1***	***127,832.1***	***127,556.0***	***127,665.5***	***128,109.5***	***130,531***	***133,214***	***136,132.6***	***139,267.6***	***142,603.2***
Variable Costs											
Total Cost of raw materials	-	74,331.1	79,286.5	84,241.9	99,108.1	99,108.1	99,108.1	99,108.1	99,108.1	99,108.1	99,108.1
Occupancy Costs (water and electricity)	21,561.6	22,208.4	22,874.7	23,560.9	24,267.8	24,995.8	25,745.7	26,518.0	27,313.6	28,133.0	28,977.0
Sales and marketing	-	4,594.5	4,900.8	5,207.1	6,125.9	6,125.9	6,125.9	6,125.9	6,125.9	6,125.9	6,125.9
total variable costs	***21,561.6***	***101,134.0***	***107,061.9***	***113,010***	***129,502***	***130,230***	***130,981***	***131,752***	***132,548***	***133,367***	***134,211***
Revenues											
Quantity of briquettes/pellets produced (kgs)	-	1,125,000	1,200,000	1,275,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000
Price per kg in US$	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Value of Briquettes	-	304,054.1	324,324.3	344,594.6	405,405.4	405,405.4	405,405.4	405,405.4	405,405.4	405,405.4	405,405.4
Contribution margin	*Contribution Margin = 1 - (Variable Costs / Revenues)*										
Contribution margin		0.66738155	0.66989234	0.67204974	0.6805621	0.6787663	0.6769166	0.6750114	0.6730491	0.6710279	0.6689461
Break-even sales *= Total Fixed Costs / (Contribution Margin)*											
Break-even sales		**192,630.65**	**190,824.87**	**189,801.43**	**187,588.34**	**188,738.72**	**192,831.51**	**197,350.28**	**202,262.48**	**207,543.64**	**213,175.94**
Break-even units = Total Fixed Costs / (Price per Unit - Variable Cost per Unit)											
Break-even units/quantity		**712,733.4**	**706,052.0**	**702,265**	**694,077**	**698,33**	**713,477**	**730,196**	**748,371**	**767,912**	**788,751**

Annex IX: Book value

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11
Civil works and built up area	97,140.0	93,934.4	90,834.5	87,837.0	84,938.4	82,135.4	79,424.9	76,803.9	74,269.4	71,818.5	69,448.5
Machinery and equipment	46,200.0	41,580.0	37,422.0	33,679.8	30,311.8	27,280.6	24,552.6	22,097.3	19,887.6	17,898.8	16,108.9
Office furniture and equipment	6,147.6	4,918.1	3,934.5	3,147.6	2,518.1	2,014.5	1,611.6	1,289.2	1,031.4	825.1	660.1
Heavy duty truck (7000 tonnes)	42,857.1	34,285.7	27,428.6	21,942.9	17,554.3	14,043.4	11,234.7	8,987.8	7,190.2	5,752.2	4,601.8
Depreciation											
Civil works and built up area	3,205.6	3,099.8	2,997.5	2,898.6	2,803.0	2,710.5	2,621.0	2,534.5	2,450.9	2,370.0	2,291.8
Machinery and equipment	4,620.0	4,158.0	3,742.2	3,368.0	3,031.2	2,728.1	2,455.3	2,209.7	1,988.8	1,789.9	1,610.9
Office furniture and equipment	1,229.5	983.6	786.9	629.5	503.6	402.9	322.3	257.8	206.3	165.0	132.0
Heavy duty truck (7000 tonnes)	8,571.4	6,857.1	5,485.7	4,388.6	3,510.9	2,808.7	2,246.9	1,797.6	1,438.0	1,150.4	920.4
	17,626.6	15,098.6	13,012.3	11,284.7	9,848.6	8,650.1	7,645.5	6,799.7	6,084.0	5,475.4	4,955.1

Annex X: Useful contacts

1. Uganda Investment Authority
TWED Plaza
Plot 22B, Lumumba Avenue
P.O. Box 7418, Kampala
Tel+ 256 414 301000
Fax+ 256 414 342903
Email: info@ugandainvest.go.ug
www.ugandainvest.go.ug

2. Ministry of Energy and Mineral Development
Amber House Kampala Road
P.O. Box 7270 Kampala,
Tel: +256- 414- 344414.
www.energyandminerals.go.ug

3. Cotton Development Organisation
Cotton House
Plot 15 Clement Hill Road
Tel: +256 414 230309
Fax: +256 414 232 975
Email: cdo@africaonline.co.ug
www.cdo.uga.org

4. National Environment Management Authority
NEMA House
Plot 17/19/21, Jinja Road
P.O. Box 22255, Kampala
Tel:+256 4 14 251064/5/8
Email: info@nemaug.org
www.nemaug.org

5. Uganda National Bureau of Standards
Standards House
Bweyogerere Industrial Park,
Plot 2 - 12, Kyaliwajala Road,
P.O Box 6329 Kampala, Uganda
Tel: + 256 417333250
Email: info@unbs.go.ug
www.unbs.go.ug

6. Uganda Revenue Authority
URA Tower
Nakawa Industrial Area
Plot M193/194
P.O. Box 7279, Kampala
Call center Toll free line:0800117000 Email: services@ura.go.ug
www.ura.go.ug

7. Uganda Manufacturers Association
Lugogo show grounds
P.O. Box 6966, Kampala
Tel:+256 414220 285
Email: information@uma.co.u
www.uma.or.ug

8. Private Sector Foundation Uganda
Plot 43 Nakasero road
P.O. Box 7683, Kampala
Tel: +256 414 230 956
Email:psfu@psfuganda.org
www.psfuganda.org

9. Uganda National Chamber of Commerce and Industry
P.O. Box 3809, Kampala
Tel: +256 4 503024/36
Email:infor@ugandachamber.com
www.ugandachamber.com

10. Biomass Energy Efficiency Technologies Association
C/O: UNREEEA, Mukwasi House, Plot 39A,
Lumumba Avenue, Nakasero
Kampala, Uganda.
+256758373837
Email: beeta.tec@gmail.com

Annex XI: Suppliers of briquettes and pellets machines

1. SREE Engineering Works

No.7 - 1 - 1/ C, Phool Bagh,
Ferozguda, Bowenpally,
Hyderabad- 500 011,
Telangana, India.
+91-40-27751841
http://www.wealthfromwaste.com
info@wealthfromwaste.comRadhe

3. Radhe Engineering Company

l. D-111 Rajdoot Industrial Estate, 4-Umakant Pandit Udyog Nagar, Nr. Ashok Garden (Mavdi Plot), Rajkot - 360 004. (Gujarat) India.

m. Phone : +91 0281-2372567
www.radheengineering.com
E-mail :
radheengineering@gmail.com

5. Lehra Fuel-tech Private Limited

r. Ludhiana – Malerkotla Road, Opposite BP Petrol Pump, Near Shanti Tara College V.P.O. JAGERA 141117 (Punjab), INDIA

s. Phone +91-1675-242981

t. info@lehrafuel.com

u. http://www.lehrafuel.com

7. **Jay Khodiyar group**

Samrat Industrial Area, Street No. 2 Rajkot-360004, Gujarat, India
Phone: +91-8048762112
www.jaykhodiyargroup.com

9. Karunanand Hydro-Pneumatic Controls Pvt. Ltd

E-3, Anand Nagar, MIDC Additional Ambernath (E),
Mumbai, Maharashtra 421506, India
Phone: 08046026132
www.karunanandpress.com

2. Global Agrotech Engineering

k. Survey No. 257, Plot No. 13, Near Captain Pipe, Shapar (Veraval) 360024, Rajkot (Gujarat) India.
Cell: +91 99791 05200
info@globalagrotecheng.com

http://globalagrotecheng.com/

4. Ronak Engineering

n. Sanjay Sakhiya (Partner)

o. No. 13, Galaxy Industrial Estate, Survey No. 275, Near Gravity Casting, Shapar (Veraval)

p. Rajkot- 360024, Gujarat, India

q. www.ronakbriquettingmachine.com

6. Ecostan India Private Limited

Ludhiana, Punjab
Ludhiana-Malerkotla Road, K. M. 23 V. P. O. Lehra, Ludhiana- 141118, Punjab, India
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https://www.ecostan.com/

8. Subhangi Construction

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Lucknow-226028, Uttar Pradesh, India
Phone: +91-8047020716

10. Henan Fote Heavy Machinery Co., Ltd.

v. 1201, 12/F, 16A, The National University Science Park,

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Annex XII: Types of Machinery

Mobile pellet machine

Briquette Press

Small Pellet machine

Dryer

Pellet packing machine

Crusher

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